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WASTEWATER TREATMENT PLANT COST ESTIMATING PROGRAM

Richard G. Eilers, et al

Black and Veatch

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By

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The program described in this report is based on preliminary cost curves received from Black and Veatch Consulting Engineers under the terms of BPA Contract No. 14-12-462. The cost data used in this report are therefore subject to change. This program will be updated to agree with the final cost curves when they are received.

INTRODUCTION

This report describes a digital computer program for estimating the capital cost, the amortization cost, and the operating and maintenance cost for conventional wastewater treatment plants made up of subsets of the processes listed in TABLE I. The approximately one hundred cost relationships used in this program were developed by Black and Veatch Consulting Engineers, Kansas City, Missouri under the terms of Contract No. 14-12-462 with the Environmental Protection Agency. At this time the terms of the contract have not been fully achieved and the cost relationships used in the program are subject to change although the probability of change is small.

The cost estimation system developed by Black and Veatch under the terms of Contract No. 14-12-462 is based on construction cost records kept by Black and Veatch as well as their experience in consulting with municipalities on the total cost of wastewater treatment. As part of this project, Black and Veatch developed construction cost relationships for each major process. The construction cost of each process was related to the major size variable associated with the process. For example, the cost of aeration basins was related to liquid volume and the cost of settlers was related to the surface area. These independent size parameters used for cost estimating are called PRAM(I) in the computer program.

Operation and maintenance cost relationships were developed by Black and Veatch for operating labor and maintenance labor in terms of payroll hours per year for each process. Similar

TABLE 1

TREATMENT PROCESSES THAT CAN BE COSTED BY THE
WASTEWATER TREATMENT PLANT COST ESTIMATING PROGRAM

Raw Sewage Pumping
Preliminary Treatment (Grit Removal, Flow Measurement)
Preliminary Treatment (Grit Removal, Flow Measurement, Screening)
Primary Sedimentation (Single Basin)
Primary Sedimentation (Multiple Basin)
Primary Sludge Pumping
Aeration Basin Structure
Aeration Diffused Air
Mechanical Aeration Equipment
Flocsillator
Trickling Filter
Intermediate Pumping
Final or Intermediate Sedimentation (Single Basin)
Final or Intermediate Sedimentation (Multiple Basin)
Recirculation Pumping
Stabilization Ponds
Sludge Thickener
Anaerobic Digestion and Building
Aerobic Digestion
Sludge Holding Tanks
Vacuum Filtration (Landfill Disposal of Sludge)
Vacuum Filtration (Incineration Disposal of Sludge)
Centrifugation
Sludge Drying Beds
Sludge Lagoons
Multiple Hearth Incineration
Fluidized Bed Incineration
Chlorination Building and Equipment
Chlorination Contact Basin

TABLE 1 (Continued)

TREATMENT PROCESSES THAT CAN BE COSTED BY THE
WASTEWATER TREATMENT PLANT COST ESTIMATING PROGRAM

Administrative and Laboratory
Garage and Shop
Yardwork
Laboratory - Activated Sludge
Laboratory - Trickling Filter
Laboratory - Primary Plant

relationships were supplied for materials and supplies, electrical power, and total material, supply, and utility costs. An independent parameter (PRAM(I)) associated with each process was selected for operation and maintenance cost. The independent parameter for operation and maintenance cost is not necessarily the same as that selected for construction cost. For example, for chlorination contact basins the independent parameter for construction cost is liquid volume while the independent parameter for operation and maintenance is tons of chlorine used per year.

Design parameters such as detention time or overflow rates are sometimes given specific names in the program. When no specific name is given, the design parameter is called VAR(I).

An excess capacity factor (ECF) is provided as a multiplier on the size (PRAM(I)) of each process. The excess capacity factor is provided to allow the engineer to provide standby capacity or to allow for conservatism in design. ECF is a required input for each process and is used in the program to specify which processes are to be included in the plant. If ECF is positive, the process is included. If ECF is zero, the process is omitted.

The design relationships used in the program for sizing the individual processes have been made as simple as possible. The "Ten State Standards" were used in most cases. Engineering relationships were used to compute the quantity of sludge produced, the oxygen requirements of the aerator, the volume of the return stream for the activated sludge process, etc. The derivation of these relationships is discussed in the second section of the report.

This program can be used to estimate the cost of primary sedimentation plants, activated sludge plants, and trickling filter plants. Cost estimates generated by the program for various sizes of plants are shown in the third section of this report.

This program is written in FORTRAN and is designed to run on a 16K IBM 1130 computer. Costs associated with the individual processes are calculated and printed out. The program then sums the individual process costs to give the total capital cost as well as the total treatment costs in cents per 1000 gallons of influent.

DESIGN RELATIONSHIPS USED

Raw sewage pumping and both classes of preliminary treatment are sized for the peak diurnal flow (QP, mgd).

The size of the primary settler in thousands of square feet of surface area is found from the design flow (QD, mgd) which is the average diurnal dry weather flow and the overflow rate, VAR(4) for single basins and VAR(5) for multiple basins. The dimensions of VAR(4) and VAR(5) is gallons per day per square foot.

The volume flow and the mass flow of the sludge stream from the primary settler must be calculated. This is done using the three input values; SSIN, the concentration of suspended solids in the feed stream to the primary settler, PSD, the percent removal of suspended solids, and PSR, the percent dry solids in the underflow stream. The volume flow of the primary sludge stream is computed as follows:

QPS, mgd = QD*SSIN*PSR/100./PSD/10000.

When a secondary process, such as the activated sludge process or the trickling filter, is used the sludge stream from the secondary process is combined with the primary sludge stream. When no secondary process is specified, the mass flow for the sludge stream is computed as follows:

PSDD, lb dry solids/day = PSD*10000.*QPS*8.33

The size of raw sludge pumps on the underflow stream from the primary settler are based on QPS.

The liquid volume of the aerator (PRAM(7), thousands of cubic feet) for the activated sludge process is computed using the detention time (VAR(7), hours) and the design flow QD. The relationship used is as follows:

PRAM(7) = 1000.*QD*VAR(7)/24./7.48

To size ancillary equipment such as diffused air equipment and blowers, mechanical aerators, return pumps, and sludge wasting pumps, it is necessary to make several additional computations. The basis for these computations is EPA Report No. WP-20-9,"Preliminary Design and Simulation of Conventional Wastewater Renovation Systems Using the Digital Computer".

Parameters associated with the activated sludge process which must be supplied as input are MLVSS, the mixed liquor volatile suspended solids concentration to be held in the aerator, FOOD, the 5-day BOD converted to suspended solids in the aerator, URSS, the compaction ratio in the final settler, and DNH3, the concentration of ammonia nitrogen in the influent stream. When DNH3 is assigned a positive value, it is assumed that nitrification will occur in the aerator and that the oxygen needed to support nitrification must be supplied.

The volume (QAS, mgd) of the waste activated sludge stream is computed in the report referenced above as equation (14). By neglecting the suspended solids which escape over the final settler weirs and by assuming that the active solids are 0.6 of the MLVSS, we derive the following simplified version of equation (14) from the referenced report:

QAS, mgd = 0.65*QD*FOOD/MLVSS/0.6/URSS - 0.125*VAER/URSS

In this expression VAER is the volume of the aerator in millions of gallons, and 0.125 is the fraction of active solids which are destroyed each day as a result of endogenous respiration when the water temperature is 20°C. The value of the endogenous respiration constant at 28°C is 0.18.

Equation (23) of the referenced report was used to compute RTURN, defined as the volume flow of the return stream divided by QD. In simplifying this equation it was assumed that active solids equal MLVSS and that the endogenous respiration constant equals 0.18. Both of these assumptions tend to overestimate the volume of the return stream. The simplified equation is given as follows:

RTURN = (1. - 0.65*FOOD/MLVSS + 0.18*VAER/QD)/(URSS - 1.)

The oxygen requirement of the activated sludge process is computed from equations (41) and (42) of the referenced report. The simplifying assumptions used here are that active solids represent 0.6 of the MLVSS and that the endogenous respiration constant is 0.125 corresponding to 20°C water temperature. When DNH3 is positive it is assumed that nitrification has occurred. The pounds of oxygen required per day is then computed as follows:

POD = 8.33*(0.58*FOOD*QD + 1.16*0.125*MLVSS*0.6*VAER) + DNH3*4.6*QD*8.33

When a diffused air system is used the aeration efficiency, expressed as a fraction, is supplied as input. This process parameter is called VAR(8) and has a nominal value of (0.05). Thousands of standard cubic feet of air required per day is then computed as follows:

PRAM(8) = POD/0.075/0.232/VAR(8)/1440./1000.

The transfer efficiency for mechanical aerators is expressed as pounds of oxygen transferred per horsepower-hour. This parameter is called VAR(9) in the program and has a nominal value of about 3.5 lb oxygen/ horsepower-hr. The horsepower of the mechanical aeration system is then computed as follows:

```
PRAM(9) = POD/24./VAR(9)
```

When a secondary process is used, it is assumed that the waste activated sludge is mixed with the primary sludge before being thickened, digested, dewatered or incinerated. It is assumed that MLVSS is 0.7 of the mixed liquor suspended solids. The total number of pounds of dry sludge produced in one day is then computed as follows:

```
PSDD = (PSD*10000.*QPS + MLVSS/.7*URSS*QAS)*8.33
```

The surface area of the final settlers is found from the input value for overflow rate (VAR(13), gal/day/sq.ft.) and QD times (1. + RTURN).

Recirculation pumps for the activated sludge process are sized using the product of QD and RTURN.

Trickling filters are sized using the parameter VAR(11) defined as mgd/acre. The value for VAR(11) is in the range 5-10 for high rate operation and in the range 2-5 for standard rate. The active volume for trickling filters was taken as the surface area times six feet. The volume of the trickling filter in thousands of cubic feet is then computed as follows:

```
PRAM(11) = QD/VAR(11)*43560.*6./1000.
```

The value of RTURN for trickling filters was set at 1.5. The volume of the sludge wasting stream from the final settler serving the trickling filter was taken as 0.029 times QD. The concentration of suspended solids in the waste stream was set at 180 mg/l.

Stabilization ponds are sized using SPL which is defined as pounds of 5-day BOD per acre per day. Nominal values for SPL fall in the range of 30-50. To size stabilization ponds the 5-day BOD of the feed stream, VAR(16), must be supplied as input. The acreage of the stabilization pond is then computed as follows:

PRAM(16), acres = QD*VAR(16)*8.33/SPL

The sum of QAS and QPS is called QT and is used to size the surface area of the sludge thickeners. The overflow rate used for design of the thickeners is VAR(17), gallons/day/sq.ft. The surface area of the thickeners expressed as thousands of square feet is then computed as follows:

PRAM(17) = QT*1000./VAR(17)

Anaerobic digesters are assumed to be of the completely mixed variety and the principal design parameter used is detention time in days called VAR(18) in the program. The concentration of suspended solids in the underflow stream from the thickener is supplied as input (TSS12). The volume of the sludge stream to the digester is then computed as follows when a thickener is used:

Q12 = PSDD/TSS12/8.33

When no thickener is used Q12 is set equal to QT.

The volume of the anaerobic digester in thousands of cubic feet is then computed as follows:

PRAM(18) = VAR(18)*Q12*1000./7.48

A nominal value for VAR(18) is 15 days.

The anaerobic process performed by the digester is assumed to have no effect on the sludge volume, but the suspended solids are assumed to be reduced by a fraction designated as SRED. In sizing the sludge holding tank which serves the vacuum filter, the volume of sludge is taken as Q12, mgd. The detention time in the sludge holding tank is designated as VAR(20), hours. The volume of the sludge holding tank in thousands of cubic feet is then computed as follows:

PRAM(20) = Q12*VAR(20)/24.*1000./7.48

The vacuum filter is sized using the parameter VAR(21), gallons/hr./sq.ft. Since it is normal practice to use the vacuum filter during only a portion of each day, the additional parameter TVF is used to express the fraction of the day the vacuum filter is in use. For example, if the vacuum filter is to be used only eight hours per day, the filter area required will be three times that required on a 24-hour basis. The vacuum filter area in square feet is computed as follows for landfill disposal:

PRAM(21) = Q12*1000000./24./TVF/VAR(21)

If a centrifuge is used to dewater the sludge instead of a vacuum filter, equipment cost is given in terms of firm capacity in gallons per minute. No costs for operation and maintenance are now included in the program. The fraction of the day used for centrifugation of sludge is designated as VAR(23). The size of the centrifuge in gallons per minute is computed as follows:

PRAM(23) = Q12*1000000./1440./VAR(23)

Sludge drying beds are sized using a loading factor with the dimensions lb dry solids/month/sq.ft. This parameter is designated as VAR(24) in the program. It is assumed that only anaerobically digested sludge will be applied to the sludge drying beds. The size of the sludge drying beds in thousands of square feet is computed as follows:

PRAM(24) = PSDD*30.*SRED/VAR(24)/1000.

The size parameter for both multiple hearth and fluidized bed incinerators is pounds of dry solids per hour. The fraction of each day during which the incinerator is operated is designated as VAR(26) for the multiple hearth incinerator and VAR(27) for the fluidized bed incinerator. The size of the multiple hearth incinerator is then computed as follows:

PRAM(26) = PSDD/24./VAR(26)*SRED

Notice that the fractional reduction in sludge dry solids (SRED) applies to all solids rather than to volatile solids.

Input values for chlorination of final effluent include the chlorine dose in mg/l and the contact time in minutes. Nominal values for chlorination of secondary effluent are 8 mg/l for the chlorine dose and 15 minutes contact time. The chlorine dose in pounds of chlorine per day PRAM(28) is computed as QD*VAR(28)*8.33. The liquid volume of the chlorine contact tank in thousands of cubic feet is computed as follows:

PRAM(29) = QD*VAR(29)/1.44/7.48

Capital costs are computed for Administrative and Laboratory Facilities, Garage and Shop, and Land. All three of these cost items are a function

of the design flow, QD. The term Yardwork is used in two ways. First as a capital cost item which refers to the interprocess piping. An allowance of 14% of the total process cost is used for interprocess piping. The term Yardwork is also used to refer to maintenance of the plant grounds which is treated as a yearly operation and maintenance cost.

Engineering costs are based on the sum of process cost and interprocess piping (yardwork). A relationship between engineering cost and total process cost is provided.

Legal, Fiscal, and Administrative cost is based on the sum of total process cost, land, and engineering cost. A relationship is provided.

Interest During Construction is based on the sum of all costs. A relationship is provided which depends on the rate of interest used as input. Note that the only interest rates that may be specified are .04, .06, and .08.

USING THE PROGRAM

The Wastewater Treatment Plant Cost Estimating Program can be used to compute the various costs associated with building and operating sewage treatment plants on a process by process basis. The user selects the processes that he wishes to include in the computation from TABLE 1. Depending on the particular processes which are selected, the user must supply input variables to the program as described in FIGURE A-2 of the APPENDIX. Several of the processes depend only on the plant volume flow, and for these processes, it is not necessary to input this design variable several times. Plant design flow, average flow, peak flow, hourly labor pay rate, indirect labor percentage, amortization interest rate, amortization period, construction cost index, and labor cost index are all specified on a single input card. It is important to note that for any process used, an excess capacity factor must always be specified with the input. If the user does not desire to use an excess capacity factor for a particular process, he still needs to input 1.0 for the excess capacity factor of that process. By doing this, the user provides for no excess capacity for that process.

The program is very simple to use, and how to use it can best be described by preparing a sample case to be run on the program. The reader is advised to refer to the first page of the APPENDIX and FIGURE A-2 of the APPENDIX in following through this example.

The first 35 input cards on the execute deck contain the alphanumeric names and design parameter units of the 35 processes that can be costed with the program. The program only reads these cards once,

and they are used only for final printout purposes. Note that these cards are always needed to execute the program but never change.

The next card (Input Card 1) specifies the number of cases to be executed by the program. The following card (Input Card 2) contains the user's own descriptive title for the particular case to be executed. Input Card 3 begins the actual computational data for the case. Input Card 4 begins the cards which specify the processes to be used and the input design variables and excess capacity factors associated with them.

Using the program, suppose we wish to cost a 1 mgd activated sludge plant with sludge drying beds for sludge disposal with the following processes:

Raw Sewage Pumping
Preliminary Treatment (Grit Removal, Flow Measurement, Screening)
Primary Sedimentation (Multiple Basin)
Primary Sludge Pumping
Aeration Basin Structures
Aeration Diffused Air System
Final Sedimentation (Multiple Basin)
Recirculation Pumping
Sludge Thickener
Anaerobic Digestion and Building
Sludge Drying Beds
Chlorination Building and Equipment
Chlorination Contact Basin
Administrative and Laboratory
Garage and Shop
Laboratory - Activated Sludge

Input Cards 1 and 2 are obvious. On Input Card 3 let us specify the following input values:

```
      QD = 1.0
      QA = .75
      QP = 1.9
     DHR = 3.75
     PCT = 15.
      RI = .06
     YRS = 25.
     CCI = 1.0
     CPI = 1.0
   CCINT = .06
```

Input Card 4 begins the input data for the various processes used. Referring to FIGURE A-2, the user sees that "Raw Sewage Pumping" has an identification number of 1 (NP), no input variable (PN) is required since it depends only on QP, and the excess capacity factor (EN) is required. Input Card 4 would then have the following data on it:

```
NP = 1
PN = ----
EN = 1.0
```

Since NP is not equal to 4, 5, 7, 16, 17, 18, 21, or 22; no additional input card is required for "Raw Sewage Pumping". The input card for "Preliminary Treatment" would be similar:

```
NP = 3
PN = ----
EN = 1.0
```

The input card for "Primary Sedimentation" would be:

```
NP = 5
PN = 800.,(gpd/sq ft, design overflow rate)
EN = 1.2
```

Since NP = 5, additional input is required for this process, so the next input card would contain the following data:

```
     PSR = 65.
     PSD = 5.
    SSIN = 250.
```

The user would now proceed in preparing his input for the remaining additional processes in a like manner. When the last process input card of this case is specified, the user ends the case with a blank card. The next case begins over again with Input Card 2, etc.

The actual input data cards for the sample case that was discussed here are pictured in FIGURE A-1 of the APPENDIX.

Since linear and polynomial curve fitting techniques were used to obtain the mathematical cost relationships that are used in this program, the cost calculations are only valid over the range of the regression data points used to generate the cost equations. TABLE 2 gives the valid ranges for the construction cost design parameters that are calculated by the program. TABLE 3 gives the valid ranges for the operation and maintenance hours design parameters that are calculated by the program. TABLE 4 gives the valid ranges for the materials and supplies cost design parameters that are calculated by the program.

In using the program, it might be well for the user to always check that the design parameters the program calculates, based on his input variables, lie within these ranges. Note that for many of the relationships used in the program, the actual computations that are made from design parameters falling outside the valid ranges that are specified might still be good estimates, since many of the relationships used are linear.

FIGURES 1, 2, and 3 show three sample graphs that can be generated using output from this program.

TABLE 2

CONSTRUCTION COST

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Raw Sewage Pumping	PRAM(1)	mgd	.2 - 1000
Preliminary Treatment (Grit Removal, Flow Measurement)	PRAM(2)	mgd	1 - 200
Preliminary Treatment (Grit Removal, Flow Measurement, Screening)	PRAM(3)	mgd	1 - 200
Primary Sedimentation (Single Basin)	PRAM(4)	sq ft	1000 - 30,000
Primary Sedimentation (Multiple Basin)	PRAM(5)	sq ft	2000 - 200,000
Primary Sludge Pumping	PRAM(6)	gpm	30 - 5000
Aeration Basin Structure	PRAM(7)	cu ft	3000 - 4,000,000
Aeration Diffused Air	PRAM(8)	cfm	20 - 200,000
Mechanical Aeration Equipment	PRAM(9)	hp	20 - 5000
Flocsillator	PRAM(10)	mgd	1 - 200
Trickling Filter	PRAM(11)	cu ft	3000 - 9,000,000

TABLE 2

CONSTRUCTION COST

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

(Continued)

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Intermediate Pumping	PRAM(12)	mgd	.5 - 300
Final or Intermediate Sedimentation (Single Basin)	PRAM(13)	sq ft	1000 - 30,000
Final or Intermediate Sedimentation (Multiple Basin)	PRAM(14)	sq ft	2000 - 200,000
Recirculation Pumping	PRAM(15)	mgd	.5 - 300
Stabilization Ponds	PRAM(16)	acres	6 - 3000
Sludge Thickener	PRAM(17)	sq ft	20 - 20,000
Anaerobic Digestion and Building	PRAM(18)	cu ft	30,000 - 6,000,000
Aerobic Digestion	PRAM(19)	cu ft	X
Sludge Holding Tanks	PRAM(20)	cu ft	1000 - 1,000,000
Vacuum Filtration - Landfill	PRAM(21)	sq ft	80 - 6000

TABLE 2

CONSTRUCTION COST

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

(Continued)

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Vacuum Filtration - Incinerate	PRAM(22)	sq ft	80 - 6000
Centrifugation	PRAM(23)	gpm	1.5 - 700
Sludge Drying Beds	PRAM(24)	sq ft	7000 - 4,000,000
Sludge Lagoons	PRAM(25)	sq ft	X
Multiple Hearth Incineration	PRAM(26)	lbs dry solids/hr	700 - 30,000
Fluidized Bed Incineration	PRAM(27)	lbs dry solids/hr	X
Chlorination Building and Equipment	PRAM(28)	lbs/day	20 - 8000
Chlorination Contact Basin	PRAM(29)	cu ft	3000 - 300,000
Administrative and Laboratory	PRAM(30)	mgd	1 - 100
Garage and Shop	PRAM(31)	mgd	1 - 100
Yardwork	PRAM(32)	----	--------
Laboratory - Activated Sludge	PRAM(33)	----	--------
Laboratory - Trickling Filter	PRAM(34)	----	--------
Laboratory - Primary Plant	PRAM(35)	----	--------

TABLE 3

OPERATION AND MAINTENANCE LABOR HOURS

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Raw Sewage Pumping	PRAM(1)	mgd	2 - 200
Preliminary Treatment (Grit Removal, Flow Measurement)	PRAM(2)	mgd	.8 - 100
Preliminary Treatment (Grit Removal, Flow Measurement, Screening)	PRAM(3)	mgd	.8 - 100
Primary Sedimentation (Single Basin)	PRAM(4)	sq ft	2000 - 100,000
Primary Sedimentation (Multiple Basin)	PRAM(5)	sq ft	2000 - 100,000
Primary Sludge Pumping	PRAM(6)	gpm	10 - 10,000
Aeration Basin Structure	PRAM(7)	cu ft	X
Aeration Diffused Air	PRAM(8)	cfm	80[illegible] - 100,000
Mechanical Aeration Equipment	PRAM(9)	hp	X
Flocsillator	PPAM(10)	mgd	X
Trickling Filter	PRAM(11)	cu ft	20,000 - 4,000,000

TABLE 3

OPERATION AND MAINTENANCE LABOR HOURS

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

(Continued)

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Intermediate Pumping	PRAM(12)	mgd	2 - 200
Final or Intermediate Sedimentation (Single Basin)	PRAM(13)	sq ft	1000 - 100,000
Final or Intermediate Sedimentation (Multiple Basin)	PRAM(14)	sq ft	1000 - 100,000
Recirculation Pumping	PRAM(15)	mgd	.5 - 100
Stabilization Ponds	PRAM(16)	acres	X
Sludge Thickener	PRAM(17)	sq ft	2000 - 100,000
Anaerobic Digestion and Building	PRAM(18)	cu ft	30,000 - 3,000,000
Aerobic Digestion	PRAM(19)	cu ft	X
Sludge Holding Tanks	PRAM(20)	cu ft	1000 - 300,000
Vacuum Filtration - Landfill	PRAM(21)	tons/yr	200 - 40,000

TABLE 3

OPERATION AND MAINTENANCE LABOR HOURS

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

(Continued)

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Vacuum Filtration - Incinerate	PRAM(22)	tons/yr	200 - 40,000
Centrifugation	PRAM(23)	gpm	X
Sludge Drying Beds	PRAM(24)	sq ft	12,000 - 500,000
Sludge Lagoons	PRAM(25)	sq ft	2000 - 1,000,000
Multiple Hearth Incineration	PRAM(26)	tons/yr	100 - 100,000
Fluidized Bed Incineration	PRAM(27)	tons/yr	100 - 100,000
Chlorination Building and Equipment	PRAM(28)	tons/yr	4 - 1000
Chlorination Contact Basin	PRAM(29)	cu ft	X
Administrative and Laboratory	PRAM(30)	----	--------
Garage and Shop	PRAM(31)	----	--------
Yardwork	PRAM(32)	mgd	1 - 100
Laboratory - Activated Sludge	PRAM(33)	mgd	1 - 100
Laboratory - Trickling Filter	PRAM(34)	mgd	1 - 100
Laboratory - Primary Plant	PRAM(35)	mgd	1 - 100

TABLE 4

MATERIALS AND SUPPLIES COST

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Raw Sewage Pumping	PRAM(1)	mgd	.7 - 100
Preliminary Treatment (Grit Removal, Flow Measurement)	PRAM(2)	mgd	.8 - 100
Preliminary Treatment (Grit Removal, Flow Measurement, Screening)	PRAM(3)	mgd	.8 - 100
Primary Sedimentation (Single Basin)	PRAM(4)	sq ft	2000 - 100,000
Primary Sedimentation (Multiple Basin)	PRAM(5)	sq ft	2000 - 100,000
Primary Sludge Pumping	PRAM(6)	gpm	10 - 10,000
Aeration Basin Structure	PRAM(7)	cu ft	X
Aeration Diffused Air	PRAM(8)	cfm	800 - 100,000
Mechanical Aeration Equipment	PRAM(9)	hp	X
Flocsillator	PRAM(10)	mgd	X
Trickling Filter	PRAM(11)	cu ft	20,000 - 4,000,000

TABLE 4

MATERIALS AND SUPPLIES COST

VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

(Continued)

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Intermediate Pumping	PRAM(12)	mgd	2 - 200
Final or Intermediate Sedimentation (Single Basin)	PRAM(13)	sq ft	1000 - 1,000,000
Final or Intermediate Sedimentation (Multiple Basin)	PRAM(14)	sq ft	1000 - 1,000,000
Recirculation Pumping	PRAM(15)	mgd	.5 - 100
Stabilization Ponds	PRAM(16)	acres	X
Sludge Thickener	PRAM(17)	sq ft	2000 - 100,000
Anaerobic Digestion and Building	PRAM(18)	cu ft	20,000 - 4,000,000
Aerobic Digestion	PRAM(19)	cu ft	X
Sludge Holding Tanks	PRAM(20)	cu ft	1000 - 300,000
Vacuum Filtration - Landfill	PRAM(21)	tons/yr	200 - 40,000

TABLE 4

MATERIALS AND SUPPLIES COST

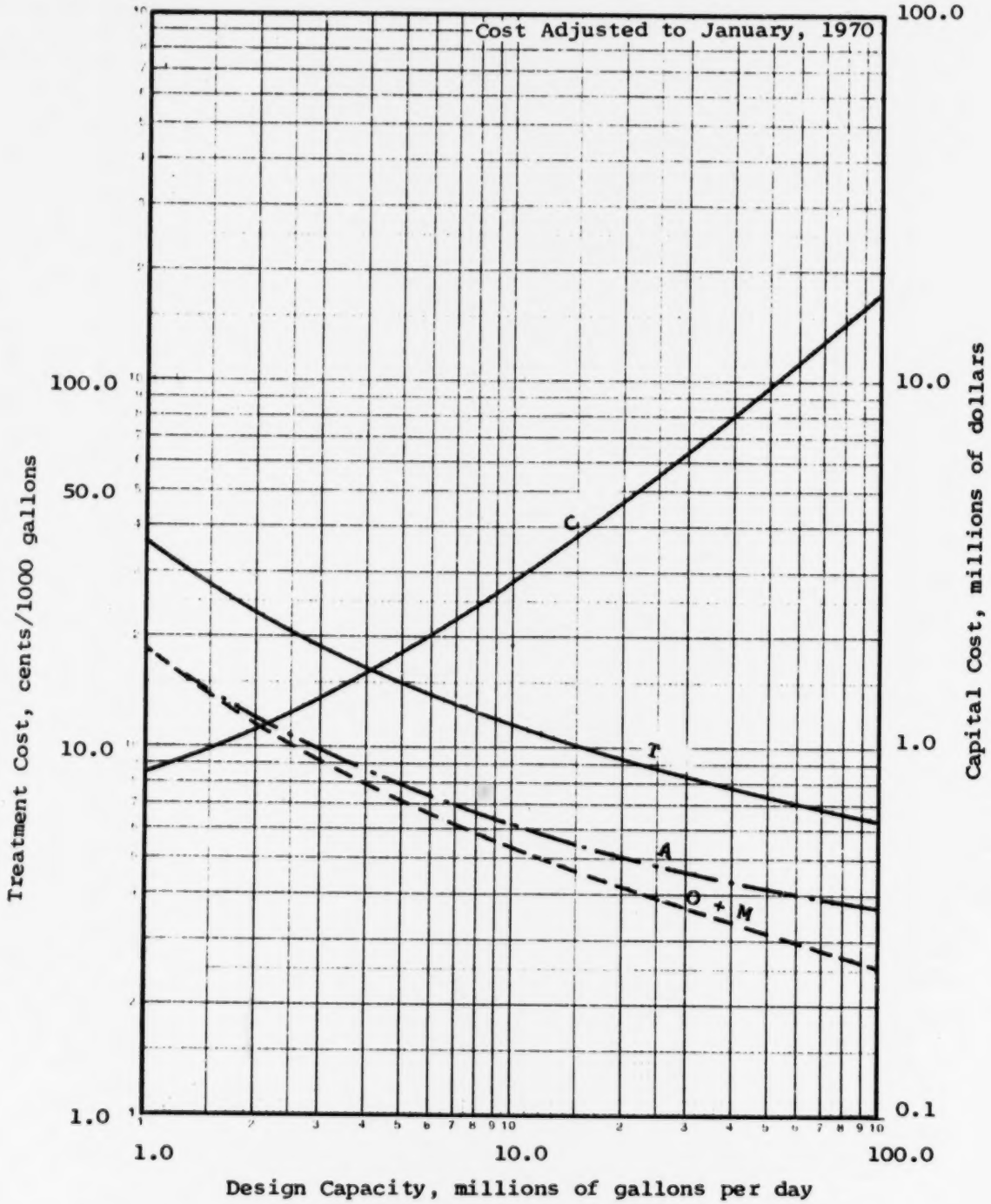
VALID RANGES FOR DESIGN PARAMETERS THAT ARE CALCULATED BY THE PROGRAM

(Continued)

PROCESS NAME	DESIGN PARAMETER	UNITS	VALID RANGE
Vacuum Filtration - Incinerate	PRAM(22)	tons/yr	200 - 40,000
Centrifugation	PRAM(23)	gpm	X
Sludge Drying Beds	PRAM(24)	sq ft	2000 - 1,000,000
Sludge Lagoons	PRAM(25)	sq ft	2000 - 1,000,000
Multiple Hearth Incineration	PRAM(26)	tons/yr	100 - 100,000
Fluidized Bed Incineration	PRAM(27)	tons/yr	100 - 100,000
Chlorination Building and Equipment	PRAM(28)	tons/yr	4 - 1000
Chlorination Contact Basin	PRAM(29)	cu ft	X
Administrative and Laboratory	PRAM(30)	----	--------
Garage and Shop	PRAM(31)	----	--------
Yardwork	PRAM(32)	mgd	1 - 100
Laboratory - Activated Sludge	PRAM(33)	mgd	1 - 100
Laboratory - Trickling Filter	PRAM(34)	mgd	1 - 100
Laboratory - Primary Plant	PRAM(35)	mgd	1 - 100

ACTIVATED SLUDGE PLANTS

Including: Raw Sewage Pumps, Preliminary Treatment-G+F+S, Primary Sedimentation, Primary Sludge Pumps, Aerators, Diffused Air System, Final Settlers-Multiple, Recirculation Pumps, Sludge Thickener, Anaerobic Digesters, Sludge Drying Beds, Chlorination, Laboratory

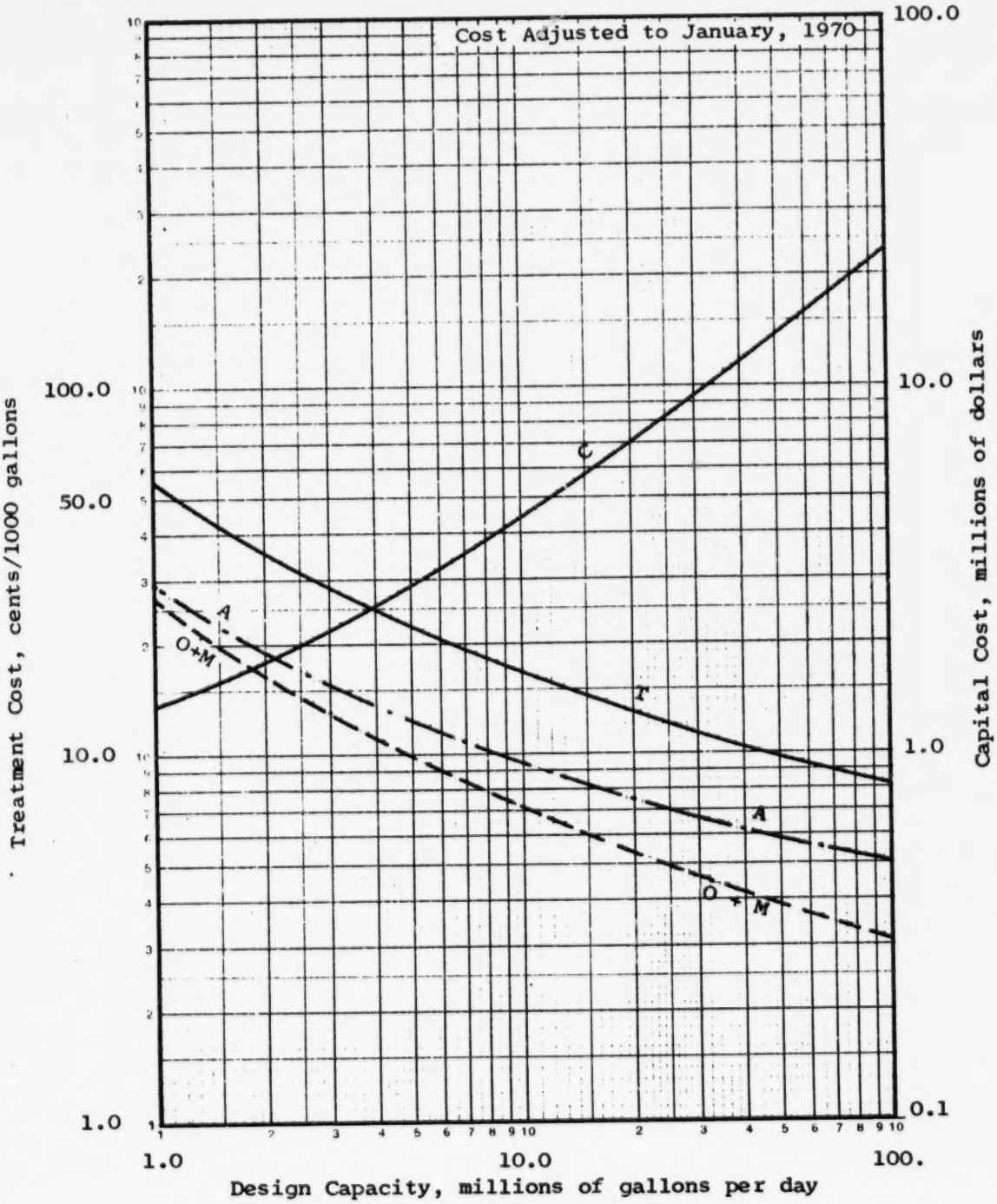


C = Capital Cost, millions of dollars
A = Debt Service, cents per 1000 gallons (6% - 25 yr.)
O + M = Operating and Maintenance Cost, cents per 1000 gallons
T = Total Treatment Cost, cents per 1000 gallons

FIGURE 1

ACTIVATED SLUDGE PLANTS

Including: Raw Sewage Pumps, Preliminary Treatment-G+F+S, Primary Sedimentation, Primary Sludge Pumps, Aerators, Diffused Air System, Final Settlers-Multiple, Recirculation Pumps, Sludge Thickener, Anaerobic Digesters, Sludge Holding Tanks, Vacuum Filtration, Multiple Hearth Incineration, Chlorination, Laboratory

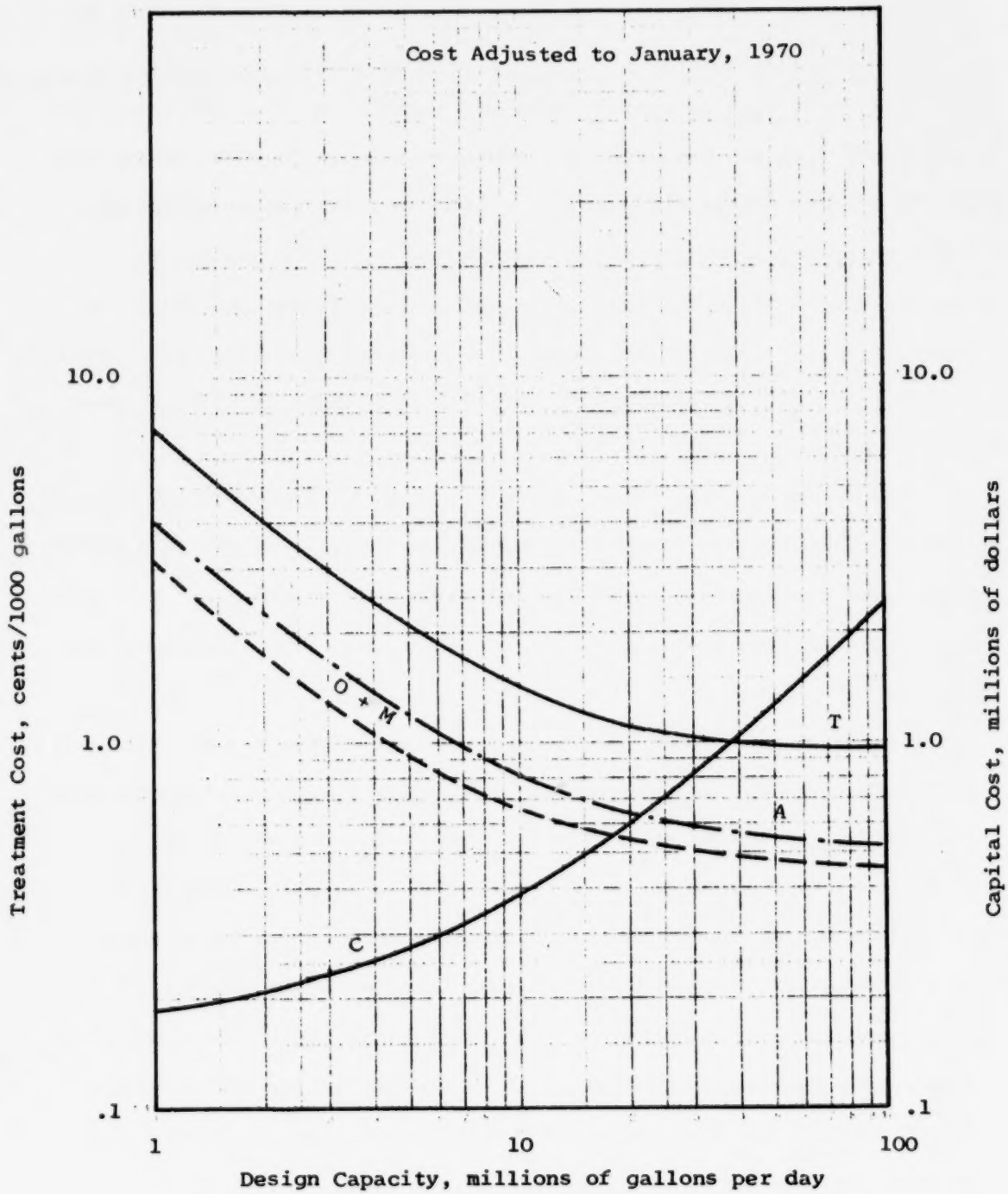


C = Capital Cost, millions of dollars
A = Debt Service, cents per 1000 gallons (6% - 25 yr.)
O + M = Operating and Maintenance Cost, cents per 1000 gallons
T = Total Treatment Cost, cents per 1000 gallons

FIGURE 2

EXTRA SLUDGE HANDLING FOR PRIMARY PLANTS WITH ALUM ADDITION

Including: Preliminary Treatment-G+F+S, Primary Sedimentation-Multiple, Primary Sludge Pumping, Sludge Thickener, Anaerobic Digesters, Sludge Drying Beds, Chlorination, Laboratory



C = Capital Cost, millions of dollars
A = Debt Service, cents per 1000 gallons (6% - 25 yr.)
O + M = Operating and Maintenance Cost, cents per 1000 gallons
T = Total Treatment Cost, cents per 1000 gallons

FIGURE 3

PRINTED OUTPUT

Each case executed by the program produces three pages of printed output. Sample output from the program is given in FIGURE A-5 of the APPENDIX to this report.

The first page of output lists the names of each of the processes used along with the corresponding design parameter that was calculated from the input design variable and excess capacity factor which were input to the program, and the corresponding capital construction cost. The individual process construction costs are totaled; and costs for yardwork, land, engineering, legal, fiscal, administrative, and interest during construction are added to arrive at a total construction cost for the entire plant.

The second page of output lists the names of each of the processes used along with the corresponding design parameter, similar to the first page. For each process used, the annual payroll man-hour requirements are given for both operation and maintenance work associated with the process. The total labor hours are then multiplied by the hourly labor rate, which is input to the program, and a direct labor cost in dollars per year is calculated. The indirect labor cost in dollars per year is calculated by multiplying the direct labor cost by a percent which is input to the program. The total annual labor cost is the sum of the direct and indirect labor costs. The total annual cost of materials, supplies, etc., associated with the process is also given in dollars per year. The total annual operation and maintenance cost in dollars per year is the sum of the total annual labor cost and the total annual materials cost. The totals for the entire plant are given at the bottom of the page.

The third page of output is a summary sheet. It lists the names of each of the processes used, the capital cost (including provisions for yardwork, land, etc. costs) in dollars, the amortization cost in cents per 1000 gallons based on interest charge and amortization period which are input to the program, the operation and maintenance cost in cents per 1000 gallons, and the total treatment cost (sum of amortization and operation and maintenance costs) in cents per 1000 gallons. For each process the input design variable, the input excess capacity factor, and the design parameter calculated by the program are also given. Miscellaneous input and output variables used by the program are given at the bottom of the page.

APPENDIX

LISTING AND OPERATING INSTRUCTIONS
FOR THE
WASTEWATER TREATMENT PLANT COST ESTIMATING PROGRAM

INPUT DATA

FOR THE

WASTEWATER TREATMENT PLANT COST ESTIMATING PROGRAM

Input Card 1: FORMAT(I2)
N

Input Card 2: FORMAT(40A2)
(LIST(I),I=1,40)

Input Card 3: FORMAT(8F10.0)
QD,QA,QP,DHR,PCT,RI,YRS,CCINT

Input Card 4: FORMAT(I2,8X,2F10.0)
NP,PN,EN

Input Card 5: FORMAT(8F10.0)
If NP on card 4 was 4: PSR,PSD,SSIN
If NP on card 4 was 5: PSR,PSD,SSIN
If NP on card 4 was 7: MLVSS,DNH3,FOOD,URSS
If NP on card 4 was 16: SPL
If NP on card 4 was 17: TSS12
If NP on card 4 was 18: SRBD
If NP on card 4 was 21: TVF
If NP on card 4 was 22: TVF
If NP on card 4 was none of these: this card is omitted

Input Cards 6 and 7, etc.: follow the pattern of cards 4 and 5, blank card ends this case, next case begins with Input Card 2

FIGURE A-1 gives an example of the card input form for the program

FIGURE A-2 gives a listing of the available processes that can be used along with its identification number and necessary input parameters

FIGURE A-3 gives the definitions of the FORTRAN variables used by the program

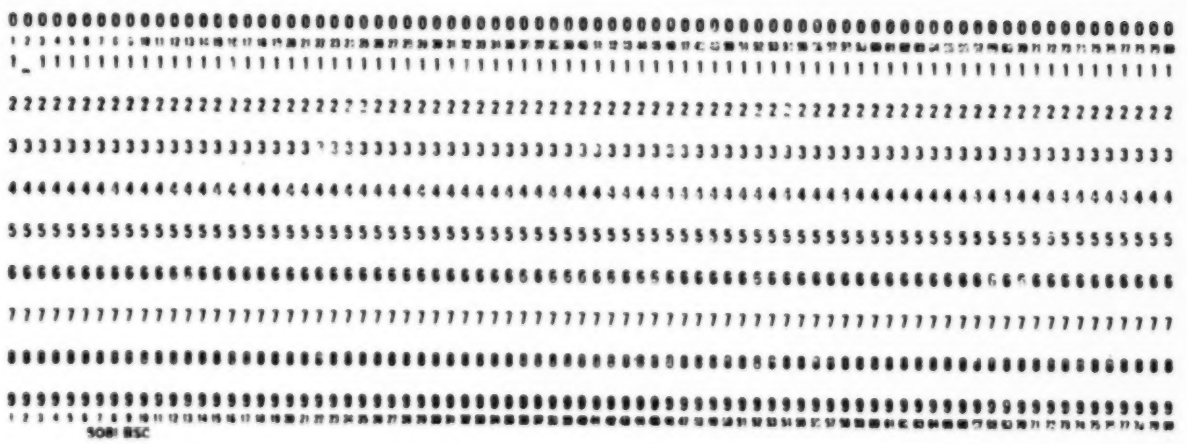
FIGURE A-4 gives the entire FORTRAN listing of the program

FIGURE A-5 gives the 3 pages of printed output from the program for the sample case given in FIGURE A-1

FIGURE A-1

Input Cards That Always Precede Data Input Cards

```
      (blank card)
33                                  1.
31                                  1.
30                                  1.
29-                  15.            1.2
29                    8.            1.5
24                   4.4            1.5
        .5
18                   15.            1.5
     50000.
17                   700.           2.
15                                  1.5
14                   300.           1.2
 8                   .05            1.5
     2000.            0.           117.          3.
 7                   4.5            1.2
-6                                  2.
       65.            5.           250.
 5                   800.           1.2
 3                                  1.
 1                                  1.
      1.      .75     1.9     3.75      .15      .06      25.      1.       1.       .06
ACTIVATED SLUDGE PLANT          1 MGD      SLUDGE DRYING BEDS
 1
```



Sample Data Input Cards to the Program

FIGURE A-2

PROCESS INFORMATION

Process Name	(NP) Identification Number	VAR(NP) Input Variable	PRAM(NP) Design Parameter	ECF(NP) Excess Capacity Factor
Raw Sewage Pumping	1	-----	PRAM(1)	ECF(1)
Preliminary Treatment (Grit Removal, Flow Measurement)	2	-----	PRAM(2)	ECF(2)
Preliminary Treatment (Grit Removal, Flow Measurement, Screening)	3	-----	PRAM(3)	ECF(3)
Primary Sedimentation (Single Basin)	4	VAR(4) PSR PSD SSIN	PRAM(4)	ECF(4)
Primary Sedimentation (Multiple Basin)	5	VAR(5) PSR PSD SSIN	PRAM(5)	ECF(5)
Primary Sludge Pumping	6	-----	PRAM(6)	ECF(6)
Aeration Basin Structure	7	VAR(7) MLVSS DNH3 FOOD URSS	PRAM(7)	ECF(7)
Aeration Diffused Air	8	VAR(8)	PRAM(8)	ECF(8)
Mechanical Aeration Equipment	9	VAR(9)	PRAM(9)	ECF(9)
Flocsillator	10	-----	PRAM(10)	ECF(10)
Trickling Filter	11	VAR(11)	PRAM(11)	ECF(11)
Intermediate Pumping	12	-----	PRAM(12)	ECF(12)
Final or Intermediate Sedimentation (Single Basin)	13	VAR(13)	PRAM(13)	ECF(13)

PROCESS INFORMATION
(Continued)

Process Name	(NP) Identification Number	VAR(NP) Input Variable	PRAM(NP) Design Parameter	ECF(NP) Excess Capacity Factor
Final or Intermediate Sedimentation (Multiple Basin)	14	VAR(14)	PRAM(14)	ECF(14)
Recirculation Pumping	15	-----	PRAM(15)	ECF(15)
Stabilization Ponds	16	VAR(16) SPL	PRAM(16)	ECF(16)
Sludge Thickener	17	VAR(17) TSS12	PRAM(17)	ECF(17)
Anaerobic Digestion and Building	18	VAR(18) SRED	PRAM(18)	ECF(18)
Aerobic Digestion	19	X	X	X
Sludge Holding Tanks	20	VAR(20)	PRAM(20)	ECF(20)
Vacuum Filtration - Landfill	21	VAR(21) TVF	PRAM(21)	ECF(21)
Vacuum Filtration - Incinerate	22	VAR(22) TVF	PRAM(22)	ECF(22)
Centrifugation	23	-----	PRAM(23)	ECF(23)
Sludge Drying Beds	24	VAR(24)	PRAM(24)	ECF(24)
Sludge Lagoons	25	X	X	X
Multiple Hearth Incineration	26	VAR(26)	PRAM(26)	ECF(26)
Fluidized Bed Incineration	27	VAR(27)	PRAM(27)	ECF(27)
Chlorination Building and Equipment	28	VAR(28)	PRAM(28)	ECF(28)
Chlorination Contact Basin	29	VAR(29)	PRAM(29)	ECF(29)
Administrative and Laboratory	30	-----	PRAM(30)	ECF(30)

PROCESS INFORMATION
(Continued)

Process Name	(NP) Identification Number	VAR(NP) Input Variable	PRAM(NP) Design Parameter	ECF(NP) Excess Capacity Factor
Garage and Shop	31	-----	PRAM(31)	ECF(31)
Yardwork	32	-----	PRAM(32)	ECF(32)
Laboratory - Activated Sludge	33	-----	PRAM(33)	ECF(33)
Laboratory - Trickling Filter	34	-----	PRAM(34)	ECF(34)
Laboratory - Primary Plant	35	-----	PRAM(35)	ECF(35)

FIGURE A-3

DEFINITIONS OF FORTRAN SYMBOLS

Computer Symbol	Definitions and Comments
AF	Amortization factor
CCI	Sewage treatment plant construction cost index to account for the variation of construction cost with time, 1957-59 = 1.0
CCINT	Interest rate for interest cost during construction of the plant, fraction Note that this input can only be equal to .04, .06, or .08
CPI	Sewage treatment plant labor cost index to account for the variation of pay rates with time, 1957-59 = 1.0
DHR	Wastewater treatment plant hourly labor pay rate, $/hour
DNH3	Dissolved nitrogen concentration entering the aerator, mg/l
BCF(I)	Excess capacity factors for the processes; an excess capacity must be supplied for each process that is used - setting it equal to 1.0 provides for no excess capacity for the particular process
EN	Fortran variable that is used internally by the program to read in the excess capacity factors from input cards
FOOD	The total change in the 5-day BOD concentration across the aeration process, mg/l
LIST (I)	Alpha-numeric integer input vector that is used to read in and print out a descriptive title on the program output
MLVSS	Concentration of volatile solids held in the aerator, mg/l
N	Integer input to the program that specifies the number of cases to be executed by the program
NP	Fortran variable that is used internally by the program to read in the process identification numbers from input cards
PCT	Fraction of direct labor cost that is charged as indirect labor cost, fraction
PN	Fortran variable that is used internally by the program to read in the input design variable from input cards

DEFINITIONS OF FORTRAN SYMBOLS

Computer Symbol	Definitions and Comments
POD	Oxygen requirements of the activated sludge process, lbs of O_2 required/day
PRAM(1)	Initial firm pumping capacity of raw sewage pumps, mgd
PRAM(2)	Maximum capacity of preliminary treatment process using grit removal and flow measurement, mgd
PRAM(3)	Maximum capacity of preliminary treatment process using grit removal and flow measurement and screening, mgd
PRAM(4)	Surface area of the primary settler (single basin), sq ft
PRAM(5)	Surface area of the primary settler (multiple basin), sq ft
PRAM(6)	Initial firm pumping capacity of the primary sludge pumps, gpm
PRAM(7)	Liquid volume of the aerator, cu ft
PRAM(8)	Initial firm aerator blower capacity, cfm
PRAM(9)	Total installed capacity for mechanical aeration, horsepower
PRAM(10)	Plant average day flow capacity for flocsillator, mgd
PRAM(11)	Trickling filter media volume, cu ft
PRAM(12)	Initial firm pumping capacity of intermediate pumps, mgd
PRAM(13)	Surface area of the final settler (single basin), sq ft
PRAM(14)	Surface area of the final settler (multiple basin), sq ft
PRAM(15)	Initial firm pumping capacity of recirculation pumps, mgd
PRAM(16)	Stabilization pond surface area, acres
PRAM(17)	Surface area of the sludge thickener, sq ft
PRAM(18)	Sludge volume for anaerobic digestion, cu ft
PRAM(19)	X
PRAM(20)	Sludge volume for holding tanks, cu ft

Computer Symbol	Definitions and Comments
PRAM(21)	Vacuum filter area (with landfill disposal), sq ft
PRAM(22)	Vacuum filter area (with incineration disposal) sq ft
PRAM(23)	Firm capacity of centrifuge, gpm
PRAM(24)	Surface area of sludge drying beds, sq ft
PRAM(25)	X
PRAM(26)	Multiple hearth incineration capacity, lbs dry solids/hour
PRAM(27)	Fluidized bed incineration capacity, lbs dry solids/hour
PRAM(28)	Average chlorine use at design flow, lbs/day
PRAM(29)	Liquid volume of chlorine basin, cu ft
PRAM(30)	Plant average day flow capacity, mgd
PRAM(31)	Plant average day flow capacity, mgd
PRAM(32)	Plant average day flow capacity, mgd
PRAM(33)	Plant average day flow capacity, mgd
PRAM(34)	Plant average day flow capacity, mgd
PRAM(35)	Plant average day flow capacity, mgd
PSD	Percent of solids in the flow to the primary settler, %
PSDD	Pounds of dry sludge produced/day
PSR	Percent of solids recovery in the primary settling process, %
Q12	Volume of the underflow stream from the thickener, mgd
QA	Average daily flow of the plant, mgd
QAS	Volume of the waste stream from the aeration process, mgd
QD	Design flow of the plant, mgd
QP	Peak flow capacity of the plant, mgd
QPS	Volume of the underflow stream from the primary settler, mgd

Computer Symbol	Definitions and Comments
QT	Sum of QAS and QPS, mgd
RATIO	Ratio of total construction cost of the plant including costs for land, engineering, etc. to total construction cost excluding costs for land, engineering, etc.
RI	Amortization interest rate, fraction
RTURN	Return ratio for the aerator or trickling filter, return stream, mgd/influent stream, mgd
SPL	Stabilization pond loading, lbs 5-day BOD/acre/day
SRED	Sludge reduction in the digestion process, fraction
SSIN	Suspended solids concentration entering the primary settler, mg/l
TSS12	Total suspended solids concentration in the underflow stream from the thickener, mg/l
TVF	Fraction of the time the vacuum filters are operated, fraction
URSS	Ratio of solids concentration in the underflow stream from the final settler to the total solids concentration in the aerator
VAER	Volume of the aerator, millions of gallons
VAR(1)	Not used
VAR(2)	Not used
VAR(3)	Not used
VAR(4)	Design overflow rate for the primary settler (single basin), gpd/sq ft
VAR(5)	Design overflow rate for the primary settler (multiple basin), gpd/sq ft
VAR(6)	Not used
VAR(7)	Aerator detention time, hours
VAR(8)	Efficiency of diffusers in aerator, fraction
VAR(9)	Transfer efficiency for mechanical aerators, lbs oxygen transferred/horsepower-hour

DEFINITIONS OF FORTRAN SYMBOLS

Computer Symbol	Definitions and Comments
VAR(10)	Not used
VAR(11)	Trickling filter hydraulic loading, mgd/acre
VAR(12)	Not used
VAR(13)	Design overflow rate for the final settler (single basin), gpd/sq ft
VAR(14)	Design overflow rate for the final settler (Multiple basin), gpd/sq ft
VAR(15)	Not used
VAR(16)	5-day BOD concentration of the feed stream to the stabilization pond, mg/l
VAR(17)	Design overflow rate for the thickener, gpd/sq ft
VAR(18)	Anaerobic digester detention time, days
VAR(19)	X
VAR(20)	Sludge holding tanks detention time, hours
VAR(21)	Vacuum filter loading (with landfill disposal), gallons/hr/sq ft
VAR(22)	Vacuum filter loading (with incineration disposal), gallons/hr/sq ft
VAR(23)	Fraction of time the centrifuge is operated, fraction
VAR(24)	Sludge bed loading, lbs of solids/ft^2 of bed area/month
VAR(25)	X
VAR(26)	Fraction of time the multiple hearth incinerator is operated, fraction
VAR(27)	Fraction of time the fluidized bed incinerator is operated, fraction
VAR(28)	Dose of chlorine, mg/l
VAR(29)	Chlorine contact time, minutes
VAR(30)	Not used

DEFINITIONS OF FORTRAN SYMBOLS

Computer Symbol	Definitions and Comments
VAR(31)	Not used
VAR(32)	Not used
VAR(33)	Not used
VAR(34)	Not used
VAR(35)	Not used
YRS	Amortization period, years

FIGURE A-4


```
      REAL MLVSS
      DIMENSION NAME(525),NAMEA(140),LIST(40),PRAM(35),VAR(35),
     . CCOST(35),ECF(35),OHRS(35),XMHRS(35),THRS(35),DLAB(35),CCST1(35),
     . XILAB(35),TLAB(35),TMSU(35),TOMC(35),ACOST(35),COSTO(35),TTC(35)
      IN=2
      IC=5
      J1=1
      J2=1
      DO 2 K=1,35
      JJ1=J1+14
      JJ2=J2+3
      READ(IN,3) (NAME(I),I=J1,JJ1),(NAMEA(I),I=J2,JJ2)
      J1=J1+15
    2 J2=J2+4
    3 FORMAT(15A2,20X,4A2)
      READ(IN,5) NCASE
    5 FORMAT(I2)
      DO 1000 IJ=1,NCASE
      DO 10 I=1,35
      PRAM(I)=0.
      ECF(I)=0.
      CCST1(I)=0.
      CCOST(I)=0.
      ACOST(I)=0.
      COSTO(I)=0.
      TTC(I)=0.
      VAR(I)=0.
      OHRS(I)=0.
      XMHRS(I)=0.
      THRS(I)=0.
      DLAB(I)=0.
      XILAB(I)=0.
      TLAB(I)=0.
      TMSU(I)=0.
   10 TOMC(I)=0.
      QD=0.
      QA=0.
      QP=0.
      CCINT=0.
      PSR=0.
      PSD=0.
      SSIN=0.
      MLVSS=0.
      DNH3=0.
      FOOD=0.
      URSS=0.
      SPL=0.
      SRED=0.
      TSS12=0.
      QPS=0.
      QAS=0.
      QT=0.
      VAER=0.
      RTURN=0.
      POD=0.
      PSDD=0.
      Q12=0.
```

```
      TVF=0.
      PCT=0.
      DHR=0.
      RI=0.
      YRS=0.
      AF=0.
      RATIO=0.
      READ(IN,15) LIST
   15 FORMAT(40A2)
      READ(IN,21) QD,QA,QP,DHR,PCT,RI,YRS,CCI,CPI,CCINT
   21 FORMAT(10F8.0)
   20 FORMAT(8F10.0)
      DO 46 I=1,36
      READ(IN,25) NP,PN,EN
   25 FORMAT(I2,8X,2F10.0)
      IF(NP) 30,49,30
   30 VAR(NP)=PN
      ECF(NP)=EN
      IF(NP-4) 32,31,32
   31 READ(IN,20) PSR,PSD,SSIN
   32 IF(NP-5) 34,33,34
   33 READ(IN,20) PSR,PSD,SSIN
   34 IF(NP-7) 36,35,36
   35 READ(IN,20) MLVSS,DNH3,FOOD,URSS
   36 IF(NP-16) 38,37,38
   37 READ(IN,20) SPL
   38 IF(NP-17) 40,39,40
   39 READ(IN,20) TSS12
   40 IF(NP-18) 42,41,42
   41 READ(IN,20) SRED
   42 IF(NP-21) 44,43,44
   43 READ(IN,20) TVF
   44 IF(NP-22) 46,45,46
   45 READ(IN,20) TVF
   46 CONTINUE
   49 PRAM(1)=QP*ECF(1)
      PRAM(2)=QP*ECF(2)
      PRAM(3)=QP*ECF(3)
      QPS=QD*SSIN*PSR/100./PSD/10000.
      PSDD=PSD*10000.*QPS*8.33
      QT=QPS
      PRAM(4)=QD*1000./VAR(4)*ECF(4)
      PRAM(5)=QD*1000./VAR(5)*ECF(5)
      PRAM(6)=QPS*1000000./1440.*ECF(6)
      PRAM(7)=QD*VAR(7)/24./7.48*1000000./1000.*ECF(7)
      IF(ECF(7)) 62,64,62
   62 VAER=VAR(7)/24.*QD
      RTURN=(1.-.65*FOOD/MLVSS+.18*VAER/QD)/(URSS-1.)
      QAS=.65*QD*FOOD/MLVSS/.6/URSS-.125*VAER/URSS
      POD=8.33*(.58*FOOD*QD+1.16*.125*MLVSS*.6*VAER)+DNH3*4.6*QD*8.33
      PSDD=(PSD*10000.*QPS+MLVSS/.7*URSS*QAS)*8.33
      QT=QAS+QPS
      GO TO 68
   64 IF(ECF(11)) 66,68,66
   66 RTURN=1.5
      QAS=.029*QD
      PSDD=(PSD*10000.*QPS+QD*180.)*8.33
```

```
      QT=QAS+QPS
   68 IF(ECF(17)) 51,50,51
   50 Q12=QT
      GO TO 59
   51 Q12=PSDD/TSS12/8.33
   59 PRAM(8)=POD/.075/.232/VAR(8)/1440./1000.*ECF(8)
      PRAM(9)=POD/VAR(9)/24.*ECF(9)
      PRAM(10)=QD*ECF(10)
      PRAM(11)=QD/VAR(11)*43560.*6./1000.*ECF(11)
      PRAM(12)=QP*ECF(12)
      PRAM(13)=QD*(1.+RTURN)*1000./VAR(13)*ECF(13)
      PRAM(14)=QD*(1.+RTURN)*1000./VAR(14)*ECF(14)
      PRAM(15)=QD*RTURN*ECF(15)
      PRAM(16)=QD*VAR(16)*8.33/SPL*ECF(16)
      PRAM(17)=QT*1000./VAR(17)*ECF(17)
      PRAM(18)=VAR(18)*Q12*1000./7.48*ECF(18)
      PRAM(19)=0.
      PRAM(20)=Q12*VAR(20)/24.*1000./7.48*ECF(20)
      PRAM(21)=Q12*1000000./24./TVF/VAR(21)*ECF(21)
      PRAM(22)=Q12*1000000./24./TVF/VAR(22)*ECF(22)
      PRAM(23)=Q12*1000000./1440./VAR(23)*ECF(23)
      PRAM(24)=PSDD*30.*(1.-SRED)/VAR(24)/1000.*ECF(24)
      PRAM(25)=0.
      PRAM(26)=PSDD/24./VAR(26)*(1.-SRED)*ECF(26)
      PRAM(27)=PSDD/24./VAR(27)*(1.-SRED)*ECF(27)
      PRAM(28)=QD*VAR(28)*8.33*ECF(28)
      PRAM(29)=QD*VAR(29)/1.44/7.48*ECF(29)
      PRAM(30)=QD*ECF(30)
      PRAM(31)=QD*ECF(31)
      PRAM(32)=QD*ECF(32)
      PRAM(33)=QD*ECF(33)
      PRAM(34)=QD*ECF(34)
      PRAM(35)=QD*ECF(35)
      DO 150 I=1,10
      IF(PRAM(I)) 150,150,52
   52 X=ALOG(PRAM(I))
      GO TO(53,60,70,80,90,100,110,120,130,140),I
   53 IF(PRAM(1)-10.) 55,56,56
   55 CCOST(1)=3.9331+.51131*X-.010578*X**2.-.036632*X**3.+
     . .05346*X**4.+.013881*X**5.-.010823*X**6.
      GO TO 58
   56 CCOST(1)=3.34887+.88803*X
   58 OHRS(1)=4.97214-.24516*X+.27727*X**2.-.024816*X**3.
      XMHRS(1)=5.66839-.33032*X+.2184*X**2.-.016066*X**3.
      X=ALOG(QA*ECF(1))
      TMSU(1)=.47+.80399*X
      GO TO 150
   60 CCOST(2)=2.65708+.594235*X
      X=ALOG(QA*ECF(2))
      OHRS(2)=-.80297+.45822*X+.13532*X**2.-.01607*X**3.
      XMHRS(2)=-1.27932+.33541*X+.13728*X**2.-.01583*X**3.
      TMSU(2)=-.78064+.73697*X
      GO TO 150
   70 CCOST(3)=3.409496+.560667*X
      X=ALOG(QA*ECF(3))
      OHRS(3)=-.80297+.45822*X+.13532*X**2.-.01607*X**3.
      XMHRS(3)=-1.27932+.33541*X+.13728*X**2.-.01583*X**3.
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      TMSU(3)=-.78064+.73697*X
      GO TO 150
   80 CCOST(4)=3.4975+.476*X+.040558*X**2.-.0015942*X**3.
      OHRS(4)=-1.30713-.3655*X+.44042*X**2.-.046783*X**3.
      XMHRS(4)=-1.49242+.46345*X
      TMSU(4)=-.60065+.031959*X+.18983*X**2.-.010244*X**3.
      GO TO 150
   90 CCOST(5)=3.86946+.41421*X+.046758*X**2.
      OHRS(5)=-1.30713-.3655*X+.44042*X**2.-.046783*X**3.
      XMHRS(5)=-1.49242+.46345*X
      TMSU(5)=-.60065+.031959*X+.18983*X**2.-.010244*X**3.
      GO TO 150
  100 CCOST(6)=2.62812+.067008*X+.034317*X**2.
      OHRS(6)=-1.03164+.29313*X
      IF(PRAM(6)-2000.) 105,106,106
  105 XMHRS(6)=-2.40559+1.1472*X-.27421*X**2.+.023094*X**3.
      GO TO 107
  106 XMHRS(6)=-6.7037+.96641*X
  107 TMSU(6)=-3.17283+.72036*X
      GO TO 150
  110 CCOST(7)=2.65747-.091793*X+.14053*X**2.-.0060992*X**3.
      OHRS(7)=0.
      XMHRS(7)=0.
      TMSU(7)=0.
      GO TO 150
  120 CCOST(8)=4.14882+.62626*X+.027765*X**2.-.0039382*X**3.+
     . .00015844*X**4.
      IF(PRAM(8)-10.) 125,126,126
  125 OHRS(8)=.08375+.063278*X+.12175*X**2.
      XMHRS(8)=-.62209+.13309*X+.066967*X**2.+.036002*X**3.
      GO TO 127
  126 OHRS(8)=-.73397+.69897*X
      XMHRS(8)=-1.32176+.77815*X
  127 TMSU(8)=2.0903+.52356*X
      GO TO 150
  130 CCOST(9)=1.69220+.38662*X+.035708*X**2.
      OHRS(9)=0.
      XMHRS(9)=0.
      TMSU(9)=0.
      GO TO 150
  140 IF(PRAM(10)-10.) 335,336,336
  335 CCOST(10)=2.52511+.053555*X+.0015188*X**2.+.042786*X**3.
      GO TO 150
  336 CCOST(10)=.87547+1.*X
      OHRS(10)=0.
      XMHRS(10)=0.
      TMSU(10)=0.
  150 CONTINUE
      DO 270 I=1,10
      IF(PRAM(I+10)) 270,270,160
  160 X=ALOG(PRAM(I+10))
      GO TO(170,180,190,200,210,220,230,240,250,260),I
  170 CCOST(11)=2.48618+.31847*X+.046376*X**2.
      OHRS(11)=6.66446-1.2883*X+.28329*X**2.-.014758*X**3.
      XMHRS(11)=2.117+.71151*X
      TMSU(11)=-2.93354+.48636*X
      GO TO 270
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```
  180 IF(PRAM(12)-10.) 455,457,457
  455 CCOST(12)=3.9331+.51131*X-.010578*X**2.-.036632*X**3.+
     . .05346*X**4.+.013881*X**5.-.010823*X**6.
      GO TO 458
  457 CCOST(12)=3.34887+.88803*X
  458 OHRS(12)=4.97214-.24516*X+.27727*X**2.-.024816*X**3.
      XMHRS(12)=5.66839-.33032*X+.2184*X**2.-.016066*X**3.
      X=ALOG(QA*ECF(12))
      TMSU(12)=.47+.80399*X
      GO TO 270
  190 CCOST(13)=3.4975+.476*X+.040558*X**2.-.0015942*X**3.
      OHRS(13)=5.10921+.18212*X+.2343*X**2.-.027131*X**3.
      XMHRS(13)=4.84254+.24754*X+.16862*X**2.-.019348*X**3.
      TMSU(13)=-1.99007+.68664*X
      GO TO 270
  200 CCOST(14)=3.86946+.41421*X+.046758*X**2.
      OHRS(14)=5.10921+.18212*X+.2343*X**2.-.027131*X**3.
      XMHRS(14)=4.84254+.24754*X+.16862*X**2.-.019348*X**3.
      TMSU(14)=-1.99007+.68664*X
      GO TO 270
  210 CCOST(15)=3.45772+.37244*X+.051210*X**2.-.0039547*X**3.
      OHRS(15)=6.13508+.18779*X+.072333*X**2.-.019088*X**3.
     . +.0017078*X**4.
      XMHRS(15)=5.80385+.18142*X+.056676*X**2.-.007735*X**3.
      TMSU(15)=1.06471+.25361*X
      GO TO 270
  220 CCOST(16)=2.56531+.59379*X+.019402*X**2.
      OHRS(16)=0.
      XMHRS(16)=0.
      TMSU(16)=0.
      GO TO 270
  230 CCOST(17)=3.4975+.476*X+.040558*X**2.-.0015942*X**3.
      IF(PRAM(17)-2.) 225,226,226
  225 OHRS(17)=ALOG(.25)
      XMHRS(17)=-1.49242+.46345*X
      TMSU(17)=ALOG(.5)
      GO TO 270
  226 OHRS(17)=-1.30713-.3655*X+.44042*X**2.-.046783*X**3.
      XMHRS(17)=-1.49242+.46345*X
      TMSU(17)=-.60065+.031959*X+.18993*X**2.-.010244*X**3.
      GO TO 270
  240 CCOST(18)=7.12137-1.5948*X+.32503*X**2.-.013131*X**3.
      OHRS(18)=3.92446-2.7878*X+.5527*X**2.-.028047*X**3.
      IF(PRAM(18)-500.) 235,236,236
  235 XMHRS(18)=-6.56257+4.2333*X-.97542*X**2.+.076628*X**3.
      GO TO 237
  236 XMHRS(18)=-5.61072+.97846*X
  237 TMSU(18)=1.57702-1.218*X+.30792*X**2.-.016012*X**3.
      GO TO 270
  250 CCOST(19)=0.
      OHRS(19)=0.
      XMHRS(19)=0.0
      TMSU(19)=0.
      GO TO 270
  260 CCOST(20)=2.55919+.40079*X+.[illegible]033*X**2.+.00069242*X**3.
      OHRS(20)=5.71798+.026865*X+.091227*X**2.-.0063644*X**3.
      XMHRS(20)=4.49623+.15659*X+.10283*X**2.-.0084718*X**3.
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      TMSU(20)=-1.89712+.66182*X
  270 CONTINUE
      DO 390 I=1,10
      IF(PRAM(I+20)) 390,390,280
  280 X=ALOG(PRAM(I+20))
      GO TO(290,300,310,320,330,340,350,360,370,380),I
  290 CCOST(21)=2.76175+.34942*X+.023991*X**2.
      X=ALOG(PSDD*365./2000./1000.*(1.-SRED))
      OHRS(21)=1.41063+.36002*X+.10505*X**2.+.015202*X**3.
     . -.0037149*X**4.
      XMHRS(21)=-.23699+.33741*X+.10898*X**2.+.020517*X**3.
     . -.0049823*X**4.
      TMSU(21)=2.96964+.69176*X
      GO TO 390
  300 CCOST(22)=2.76175+.34942*X+.023991*X**2.
      X=ALOG(PSDD*365./2000./1000.*(1.-SRED))
      OHRS(22)=1.15434+.33128*X+.10766*X**2.+.023325*X**3.
     . -.0056329*X**4.
      XMHRS(22)=-.23699+.33741*X+.10898*X**2.+.020517*X**3.
     . -.0049823*X**4.
      TMSU(22)=2.96964+.69176*X
      GO TO 390
  310 CCOST(23)=4.24067+.036719*X+.049994*X**2.
      OHRS(23)=0.
      XMHRS(23)=0.
      TMSU(23)=0.
      GO TO 390
  320 CCOST(24)=.69631+.77160*X+.017854*X**2.
      OHRS(24)=1.61876-2.1524*X+.62212*X**2.-.040449*X**3.
      XMHRS(24)=-4.03526+.96896*X
      TMSU(24)=-1.47431+.24607*X
      GO TO 390
  330 CCOST(25)=0.
      OHRS(25)=3.03903+.93753*X
      XMHRS(25)=3.61608+.53798*X
      TMSU(25)=-1.47431+.24607*X
      GO TO 390
  340 CCOST(26)=4.60974-.00070018*X+.033959*X**2.
      X=ALOG(PSDD*365./2000./1000.*(1.-SRED))
      OHRS(26)=.83935+.37404*X
      XMHRS(26)=.16216+.37426*X
      TMSU(26)=1.93282+.22092*X+.019185*X**2.-.0071469*X**3.
     . +.0017298*X**4.
      GO TO 390
  350 CCOST(27)=0.
      X=ALOG(PSDD*365./2000./1000.*(1.-SRED))
      OHRS(27)=.47+.36617*X
      TMSU(27)=1.52043+.40865*X+.010851*X**2.-.0013526*X**3.
     . +.0031205*X**4.
      GO TO 390
  360 CCOST(28)=1.38584+.31745*X+.0091765*X**2.
      X=ALOG(QD*VAR(28)*8.33*365./2000.)
      OHRS(28)=4.59645+.54148*X
      IF(PRAM(28)-60.) 355,356,356
  355 XMHRS(28)=3.22384+1.2967*X-.5176*X**2.+.074755*X**3.
      GO TO 357
  356 XMHRS(28)=.9757+.98549*X
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  357 TMSU(28)=-.7002+.71907*X
      GO TO 390
  370 CCOST(29)=2.47256+.0030838*X+.15019*X**2.-.0095688*X**3.
      OHRS(29)=0.
      XMHRS(29)=0.
      TMSU(29)=0.
      GO TO 390
  380 CCOST(30)=2.62946+.48223*X-.011671*X**2.
      OHRS(30)=-1.02165+.77882*X
      XMHRS(30)=-2.04022+.39457*X
      TMSU(30)=.22314+.50852*X
  390 CONTINUE
      DO 460 I=1,5
      IF(PRAM(I+30)) 460,460,400
  400 X=ALOG(PRAM(I+30))
      GO TO(410,420,430,440,450),I
  410 CCOST(31)=2.13016+.29221*X+.11316*X**2.-.010398*X**3.
      OHRS(31)=0.
      XMHRS(31)=0.
      TMSU(31)=0.
      GO TO 460
  420 CCOST(32)=0.
      OHRS(32)=0.
      IF(PRAM(32)-15.) 415,416,416
  415 XMHRS(32)=-.10967+.090986*X-.051292*X**2.+.049003*X**3.
      GO TO 417
  416 XMHRS(32)=-2.0162+1.0185*X
  417 TMSU(32)=-.34676+.32799*X+.026161*X**2.+.0038484*X**3.
      GO TO 460
  430 CCOST(33)=0.
      OHRS(33)=.74651+.16848*X+.11605*X**2.-.052461*X**3.
     . +.0072026*X**4.
      XMHRS(33)=-2.21103+.10916*X+.12907*X**2.-.012003*X**3.
      IF(PRAM(33)-20.) 425,426,426
  425 TMSU(33)=-.91286+.43272*X-.058121*X**2.+.039545*X**3.
      GO TO 460
  426 TMSU(33)=-2.09913+1.00657*X
      GO TO 460
  440 CCOST(34)=0.
      OHRS(34)=-.22314+.41637*X
      XMHRS(34)=-2.21103+.10916*X+.12907*X**2.-.012003*X**3.
      IF(PRAM(34)-20.) 435,436,436
  435 TMSU(34)=-.91286+.43272*X-.058121*X**2.+.039545*X**3.
      GO TO 460
  436 TMSU(34)=-2.09913+1.00657*X
      GO TO 460
  450 CCOST(35)=0.
      OHRS(35)=-.43078+.44303*X
      XMHRS(35)=-2.21103+.10916*X+.12907*X**2.-.012003*X**3.
      IF(PRAM(35)-20.) 445,446,446
  445 TMSU(35)=-.91286+.43272*X-.058121*X**2.+.039545*X**3.
      GO TO 460
  446 TMSU(35)=-2.09913+1.00657*X
  460 CONTINUE
      TCOST=0.
      DO 529 I=1,35
      IF(CCOST(I)) 515,517,515
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  515 CCOST(I)=EXP(CCOST(I))
      TCOST=TCOST+CCOST(I)
  517 IF(OHRS(I)) 519,521,519
  519 OHRS(I)=EXP(OHRS(I))*1000.
  521 IF(XMHRS(I)) 523,525,523
  523 XMHRS(I)=EXP(XMHRS(I))*1000.
  525 IF(TMSU(I)) 527,529,527
  527 TMSU(I)=EXP(TMSU(I))*1000.
  529 CONTINUE
      YARD=.14*TCOST
      TCC=ALOG(TCOST+YARD)
      FLOW=ALOG(QD)
      XLAND=2.31048+.18560*FLOW+.043970*FLOW**2.+.0019969*FLOW**3.
      XLAND=EXP(XLAND)
      ENG=2.2281+.10079*TCC+.039998*TCC**2.
      ENG=EXP(ENG)
      SUBT1=ALOG(TCOST+YARD+XLAND+ENG)
      FISC=-.30137-.013249*SUBT1+.096769*SUBT1**2.-.0049703*SUBT1**3.
      FISC=EXP(FISC)
      SUBT2=ALOG(TCOST+YARD+XLAND+ENG+FISC)
      IF(CCINT-.04) 554,558,554
  554 IF(CCINT-.06) 555,559,555
  555 IF(CCINT-.08) 556,561,556
  556 WRITE(IO,557)
  557 FORMAT(1H1,10X,'CCINT NOT EQUAL TO .04, .06, OR .08')
      GO TO 1000
  558 XINT=-7.4132+1.7799*SUBT2-.032847*SUBT2**2.
      GO TO 562
  559 XINT=-6.6068+1.6361*SUBT2-.022944*SUBT2**2.
      GO TO 562
  561 XINT=-6.9387+1.8313*SUBT2-.0[illegible]4426*SUBT2**2.
  562 XINT=EXP(XINT)
      TOTAL=TCOST+YARD+XLAND+ENG+FISC+XINT
      TCC=EXP(TCC)
      SUBT1=EXP(SUBT1)
      SUBT2=EXP(SUBT2)
      DO 575 I=1,35
  575 CCOST(I)=CCOST(I)*1000.*CCI
      TCOST=TCOST*1000.*CCI
      YARD=YARD*1000.*CCI
      TCC=TCC*1000.*CCI
      XLAND=XLAND*1000.*CCI
      ENG=ENG*1000.*CCI
      SUBT1=SUBT1*1000.*CCI
      FISC=FISC*1000.*CCI
      SUBT2=SUBT2*1000.*CCI
      XINT=XINT*1000.*CCI
      TOTAL=TOTAL*1000.*CCI
      RATIO=TOTAL/TCOST
      PRAM(4)=PRAM(4)*1000.
      PRAM(5)=PRAM(5)*1000.
      PRAM(7)=PRAM(7)*1000.
      PRAM(8)=PRAM(8)*1000.
      PRAM(11)=PRAM(11)*1000.
      PRAM(13)=PRAM(13)*1000.
      PRAM(14)=PRAM(14)*1000.
      PRAM(17)=PRAM(17)*1000.
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      PRAM(18)=PRAM(18)*1000.
      PRAM(20)=PRAM(20)*1000.
      PRAM(24)=PRAM(24)*1000.
      PRAM(25)=PRAM(25)*1000.
      PRAM(29)=PRAM(29)*1000.
      OHRS(32)=0.
      OHRS(1)=OHRS(1)/1000.
      OHRS(11)=OHRS(11)/1000.
      OHRS(12)=OHRS(12)/1000.
      OHRS(13)=OHRS(13)/1000.
      OHRS(14)=OHRS(14)/1000.
      OHRS(15)=OHRS(15)/1000.
      OHRS(20)=OHRS(20)/1000.
      OHRS(25)=OHRS(25)/1000.
      OHRS(28)=OHRS(28)/1000.
      XMHRS(1)=XMHRS(1)/1000.
      XMHRS(11)=XMHRS(11)/1000.
      XMHRS(12)=XMHRS(12)/1000.
      XMHRS(13)=XMHRS(13)/1000.
      XMHRS(14)=XMHRS(14)/1000.
      XMHRS(15)=XMHRS(15)/1000.
      XMHRS(20)=XMHRS(20)/1000.
      XMHRS(25)=XMHRS(25)/1000.
      XMHRS(28)=XMHRS(28)/1000.
      DO 1430 I=1,35
      THRS(I)=OHRS(I)+XMHRS(I)
      DLAB(I)=THRS(I)*OHR*CPI
      XILAB(I)=DLAB(I)*PCT
      TLAB(I)=DLAB(I)+XILAB(I)
 1430 TCMC(I)=TLAB(I)+TMSU(I)*CPI
      T1=0.
      T2=0.
      T3=0.
      T4=0.
      T5=0.
      T6=0.
      T7=0.
      T8=0.
      DO 1440 I=1,35
      T1=T1+OHRS(I)
      T2=T2+XMHRS(I)
      T3=T3+THRS(I)
      T4=T4+DLAB(I)
      T5=T5+XILAB(I)
      T6=T6+ILAB(I)
      T7=T7+TMSU(I)
 1440 T8=T8+TOMC(I)
      PCT=PCT*100.
      AF=RI*(1.+RI)**YRS/((1.+RI)**YRS-1.)
      TCST1=0.
      TOT=0.
      TCM=0.
      TAC=0.
      DO 1450 I=1,35
      CCST1(I)=CCOST(I)*RATIO
      TCST1=TCST1+CCST1(I)
      ACOST(I)=CCST1(I)*AF/OD/3650.
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      TAC=TAC+ACOST(I)
      COSTO(I)=TOMC(I)/QD/3650.
      TOM=TOM+COSTO(I)
      TTC(I)=ACOST(I)+COSTO(I)
 1450 TOT=TOT+TTC(I)
      WRITE(IO,500) LIST
  500 FORMAT(1H1,20X,40A2,/)
      WRITE(IO,505)
  505 FORMAT(47X,'SEWAGE TREATMENT PLANT',/,46X,
     . 'TOTAL CONSTRUCTION COST',//)
      WRITE(IO,510)
  510 FORMAT(67X,'DESIGN',11X,'CONSTRUCTION',/,66X,'PARAMETER',9X,
     . 'COST, DOLLARS',/)
      J1=1
      J2=1
      DO 524 K=1,35
      JJ1=J1+14
      JJ2=J2+3
      IF(K-32) 512,522,512
  512 IF(K-33) 514,522,514
  514 IF(K-34) 516,522,516
  516 IF(K-35) 518,522,518
  518 IF(ECF(K)) 509,522,509
  509 WRITE(IO,520) (NAME(I),I=J1,JJ1),PRAM(K),(NAMEA(I),I=J2,JJ2),
     . CCOST(K)
  520 FORMAT(20X,15A2,10X,F10.1,2X,4A2,5X,F10.0,5X,2F10.2)
  522 J1=J1+15
  524 J2=J2+4
      WRITE(IO,530)
  530 FORMAT(84X,'-----------')
      WRITE(IO,540) TCOST
  540 FORMAT(25X,'SUBTOTAL',52X,F10.0)
      WRITE(IO,550) YARD
  550 FORMAT(20X,'YARDWORK',57X,F10.0)
      WRITE(IO,530)
      WRITE(IO,560) TCC
  560 FORMAT(20X,'TOTAL CONSTRUCTION COST',42X,F10.0)
      WRITE(IO,570) XLAND
  570 FORMAT(20X,'LAND',61X,F10.0)
      WRITE(IO,580) ENG
  580 FORMAT(20X,'ENGINEERING',54X,F10.0)
      WRITE(IO,530)
      WRITE(IO,540) SUBT1
      WRITE(IO,590) FISC
  590 FORMAT(20X,'LEGAL,FISCAL + ADMINISTRATIVE',36X,F10.0)
      WRITE(IO,530)
      WRITE(IO,540) SUBT2
      WRITE(IO,600) XINT
  600 FORMAT(20X,'INTEREST DURING CONSTRUCTION',37X,F10.0)
      WRITE(IO,530)
      WRITE(IO,530)
      WRITE(IO,610) TOTAL
  610 FORMAT(20X,'TOTAL',60X,F10.0)
      WRITE(IO,1500) LIST
 1500 FORMAT(1H1,20X,40A2,//)
      WRITE(IO,1510)
 1510 FORMAT(49X,'SEWAGE TREATMENT PLANT',/,38X,'TOTAL ANNUAL OPERATION
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     .AND MAINTENANCE COST',//)
      WRITE(IO,1520)
 1520 FORMAT(50X,'ANNUAL PAYROLL MANHOURS',7X,'ANNUAL LABOR COST',7X,
     . 'TOTAL',5X,'TOTAL',/,55X,'REQUIREMENTS',20X,'IN',13X,
     . 'MATERIALS',3X,'ANNUAL')
      WRITE(IO,1530)
 1530 FORMAT(53X,'MANHOURS PER YEAR',10X,'DOLLARS PER YEAR',9X,'ETC.',
     . 6X,'O+M',/,36X,'DESIGN',63X,'COST',6X,'COST',/,35X,'PARAMETER',
     . 7X,'OPER.',3X,'MAINT.',3X,'TOTAL',4X,'DIRECT',2X,'INDIRECT',
     . 2X,'TOTAL',5X,'$/YR',6X,'$/YR',//)
      J1=1
      J2=1
      DO 1550 K=1,35
      JJ1=J1+14
      JJ2=J2+3
      IF(K-30) 1535,1545,1535
 1535 IF(K-31) 1536,1545,1536
 1536 IF(ECF(K)) 1537,1545,1537
 1537 WRITE(IO,1540) (NAME(I),I=J1,JJ1),PRAM(K),(NAMEA(I),I=J2,JJ2),
     . DHRS(K),XMHRS(K),THRS(K),DLAB(K),XILAB(K),TLAB(K),TMSU(K),TOMC(K)
 1540 FORMAT(1X,15A2,F8.1,1X,4A2,8F9.0)
 1545 J1=J1+15
 1550 J2=J2+4
      WRITE(IO,1560) T1,T2,T3,T4,T5,T6,T7,T8
 1560 FORMAT(//,1X,'TOTALS',41X,8F9.0)
      WRITE(IO,1500) LIST
      WRITE(IO,1565)
 1565 FORMAT(//,42X,'CAPITAL',3X,'DEBT COST',2X,'O+M COST',1X,
     . 'TOTAL COST',8X,'VAR',7X,'ECF',7X,'PRAM',/,42X,'COST, $',3X,
     . 'CTS/1000',3X,'CTS/1000',3X,'CTS/1000',/)
      J1=1
      DO 1580 K=1,35
      JJ1=J1+14
      IF(ECF(K)) 1566,1580,1566
 1566 WRITE(IO,1570) (NAME(I),I=J1,JJ1),CCST1(K),ACOST(K),COSTO(K),
     . TTC(K),VAR(K),ECF(K),PRAM(K)
 1570 FORMAT(1X,15A2,10X,F10.0,3F10.3,5X,3F10.2)
 1580 J1=J1+15
      WRITE(IO,1590) TCST1,TAC,TOM,TOT
 1590 FORMAT(//,1X,'TOTALS',34X,F10.0,3F10.3,////)
      WRITE(IO,1595) QD,QA,QP,PSR,PSD,SSIN,MLVSS,DNH3,FOOD,URSS,CCINT,
     . SPL,SRED,TSS12,QPS,QAS,QT,VAER
 1595 FORMAT(////,1X,'QD=   ',F12.3,2X,'QA=   ',F12.3,2X,'QP=   ',F12.3,
     . 2X,'PSR=  ',F12.3,2X,'PSD=  ',F12.3,2X,'SSIN= ',F12.3,//,1X,
     . 'MLVSS=',F12.3,2X,'DNH3= ',F12.3,2X,'FOOD= ',F12.3,2X,'URSS= ',
     . F12.3,2X,'CCINT=',F12.3,2X,'SPL=  ',F12.3,//,1X,'SRED= ',F12.3,
     . 2X,'TSS12=',F12.3,2X,'QPS=  ',F12.3,2X,'QAS=  ',F12.3,2X,
     . 'QT=   ',F12.3,2X,'VAER= ',F12.3,/)
      WRITE(IO,1596) RTURN,POD,PSDD,Q12,TVF,PCT,DHR,RI,YRS,AF,RATIO
 1596 FORMAT(1X,'RTURN=',F12.3,2X,'POD=  ',F12.3,2X,'PSDD= ',F12.3,
     . 2X,'Q12=  ',F12.3,2X,'TVF=  ',F12.3,2X,'PCT=  ',F12.3,
     . //,1X,'DHR=  ',F12.3,2X,'RI=   ',F12.3,2X,'YRS=  ',F12.3,
     . 2X,'AF=   ',F12.3,2X,'RATIO=',F12.3)
 1000 CONTINUE
      CALL EXIT
      END
```

FIGURE A-5

ACTIVATED SLUDGE PLANT 1 MGD SLUDGE DRYING BEDS

SEWAGE TREATMENT PLANT
TOTAL CONSTRUCTION COST

	DESIGN PARAMETER		CONSTRUCTION COST, DOLLARS
RAW SEWAGE PUMPING	1.9	MGD	70602.
PRELIMINARY TREATMENT G&F&S	1.9	MGD	43352.
PRIMARY SEDIMENTATION MULTIPLE	1500.0	SQ FT	57116.
PRIMARY SLUDGE PUMPING	4.5	GPM	16561.
AERATION BASIN STRUCTURES	30080.2	CU FT	41791.
AERATION DIFFUSED AIR SYSTEM	1002.2	CFM	63446.
FINAL OR INTERMED. SED. MULT.	2246.7	SQ FT	69089.
RECIRCULATION PUMPING	0.7	MGD	28595.
SLUDGE THICKENER	47.3	SQ FT	10778.
ANAEROBIC DIGESTION AND BLDG.	13867.3	CU FT	139274.
SLUDGE DRYING BEDS	11782.5	SQ FT	15001.
CHLORINATION BUILDING & EQUIP.	99.9	LBS/DAY	20951.
CHLORINATION CONTACT BASIN	1671.1	CU FT	12335.
ADMINISTRATIVE AND LABORATORY	1.0	MGD	13866.
GARAGE AND SHOP	1.0	MGD	8416.
SUBTOTAL			611180.
YARDWORK			85565.
TOTAL CONSTRUCTION COST			696745.
LAND			10079.
ENGINEERING			99688.
SUBTOTAL			806513.
LEGAL,FISCAL + ADMINISTRATIVE			11640.
SUBTOTAL			818153.
INTEREST DURING CONSTRUCTION			28063.
TOTAL			846217.

ACTIVATED SLUDGE PLANT 1 MGD SLUDGE DRYING BEDS

SEWAGE TREATMENT PLANT
TOTAL ANNUAL OPERATION AND MAINTENANCE COST

	DESIGN PARAMETER	ANNUAL PAYROLL MANHOURS REQUIREMENTS MANHOURS PER YEAR			ANNUAL LABOR COST IN DOLLARS PER YEAR			TOTAL MATERIALS ETC. COST $/YR	TOTAL ANNUAL O+M COST $/YR
		OPER.	MAINT.	TOTAL	DIRECT	INDIRECT	TOTAL		
RAW SEWAGE PUMPING	1.9 MGD	137.	255.	392.	1472.	220.	1692.	1269.	2962.
PRELIMINARY TREATMENT G&F&S	1.9 MGD	396.	255.	652.	2446.	366.	2813.	370.	3183.
PRIMARY SEDIMENTATION MULTIPLE	1500.0 SQ FT	250.	271.	521.	1955.	293.	2248.	572.	2821.
PRIMARY SLUDGE PUMPING	4.5 GPM	554.	295.	849.	3185.	477.	3663.	124.	3787.
AERATION BASIN STRUCTURES	30080.2 CU FT	0.	0.	0.	0.	0.	0.	0.	0.
AERATION DIFFUSED AIR SYSTEM	1002.2 CFM	1087.	536.	1624.	6091.	913.	7005.	8096.	15102.
FINAL OR INTERMED. SED. MULT.	2246.7 SQ FT	220.	171.	391.	1468.	220.	1689.	238.	1927.
RECIRCULATION PUMPING	0.7 MGD	439.	315.	755.	2833.	425.	3258.	2693.	5951.
SLUDGE THICKENER	47.3 SQ FT	250.	54.	304.	1142.	171.	1313.	500.	1813.
ANAEROBIC DIGESTION AND BLDG.	13867.3 CU FT	909.	457.	1367.	5127.	769.	5896.	1236.	7132.
SLUDGE DRYING BEDS	11782.5 SQ FT	599.	192.	792.	2970.	445.	3415.	420.	3835.
CHLORINATION BUILDING & EQUIP.	99.9 LBS/DAY	383.	31.	414.	1554.	233.	1787.	2992.	4780.
CHLORINATION CONTACT BASIN	1671.1 CU FT	0.	0.	0.	0.	0.	0.	0.	0.
LABORATORY - ACTIVATED SLUDGE	1.0 MGD	2109.	109.	2219.	8322.	1248.	9570.	401.	9971.
TOTALS		7698.	3076.	10775.	40407.	6061.	46468.	20165.	66634.

ACTIVATED SLUDGE PLANT 1 MGD SLUDGE DRYING BEDS

	CAPITAL COST, $	DEBT COST CTS/1000	O+M COST CTS/1000	TOTAL COST CTS/1000	VAR	ECF	PRAM
RAW SEWAGE PUMPING	97754.	2.095	0.811	2.906	0.00	1.00	1.90
PRELIMINARY TREATMENT G&F&S	60024.	1.286	0.872	2.158	0.00	1.00	1.90
PRIMARY SEDIMENTATION MULTIPLE	79081.	1.694	0.772	2.467	800.00	1.20	1500.00
PRIMARY SLUDGE PUMPING	22930.	0.491	1.037	1.529	0.00	2.00	4.51
AERATION BASIN STRUCTURES	57863.	1.240	0.000	1.240	4.50	1.20	30080.21
AERATION DIFFUSED AIR SYSTEM	87845.	1.882	4.137	6.020	0.05	1.50	1002.20
FINAL OR INTERMED. SED. MULT.	95658.	2.050	0.528	2.578	800.00	1.20	2246.79
RECIRCULATION PUMPING	39592.	0.848	1.630	2.479	0.00	1.50	0.74
SLUDGE THICKENER	14923.	0.319	0.496	0.816	700.00	2.00	47.32
ANAEROBIC DIGESTION AND BLDG.	192834.	4.132	1.954	6.086	15.00	1.50	13867.33
SLUDGE DRYING BEDS	20771.	0.445	1.050	1.496	4.40	1.50	11782.52
CHLORINATION BUILDING & EQUIP.	29008.	0.621	1.309	1.931	8.00	1.50	99.96
CHLORINATION CONTACT BASIN	17078.	0.366	0.000	0.366	15.00	1.20	1671.12
ADMINISTRATIVE AND LABORATORY	19198.	0.411	0.921	1.332	0.00	1.00	1.00
GARAGE AND SHOP	11652.	0.249	0.000	0.249	0.00	1.00	1.00
LABORATORY - ACTIVATED SLUDGE	0.	0.000	2.731	2.731	0.00	1.00	1.00
TOTALS	846217.	18.136	18.256	36.392			

QD=	1.000	QA=	0.750	QP=	1.900	PSR=	65.000	PSD=	5.000	SSIN=	250.000
MLVSS=	2000.000	DNH3=	0.000	FOOD=	117.000	URSS=	3.000	CCINT=	0.060	SPL=	0.000
SRED=	0.500	TSS12=	60000.000	QPS=	0.003	QAS=	0.013	QT=	0.016	VAER=	0.187
RTURN=	0.497	PUD=	837.040	PSDD=	2304.137	Q12=	0.004	TVF=	0.000	PCT=	14.999
DHR=	3.750	RI=	0.060	YRS=	25.000	AF=	0.078	RATIO=	1.384		

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